GOES-R Program Overview

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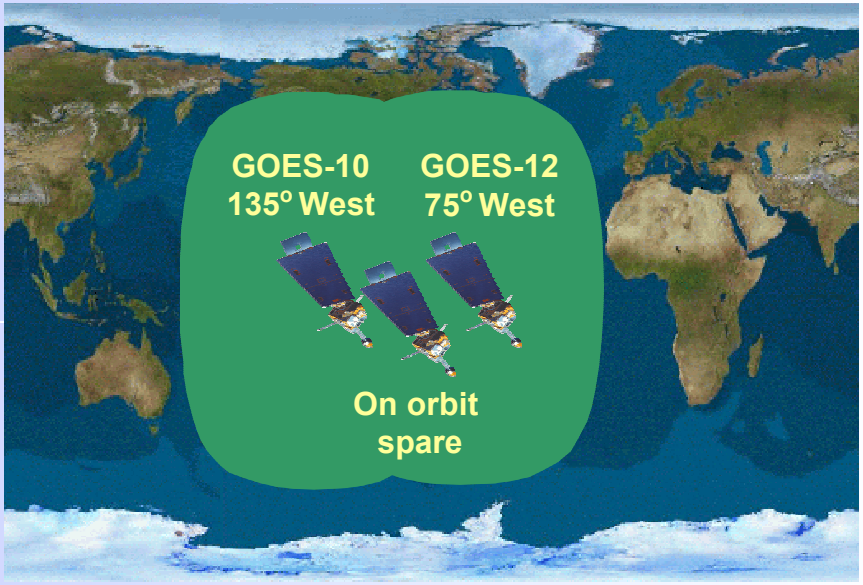
Outline of Briefing

- GOES-R Program Introduction
  - Mission/Objective
  - Customer/User
  - Team Introductions
  - Mission Requirements
  - Economic Benefits
  - System Growth
- Program Schedule
- System Architect Study

GOES Mission

- Satisfies national operational environmental requirements for 24 hour observation of weather and Earth's environment
  - Support storm-scale weather forecasting and numerical modelers

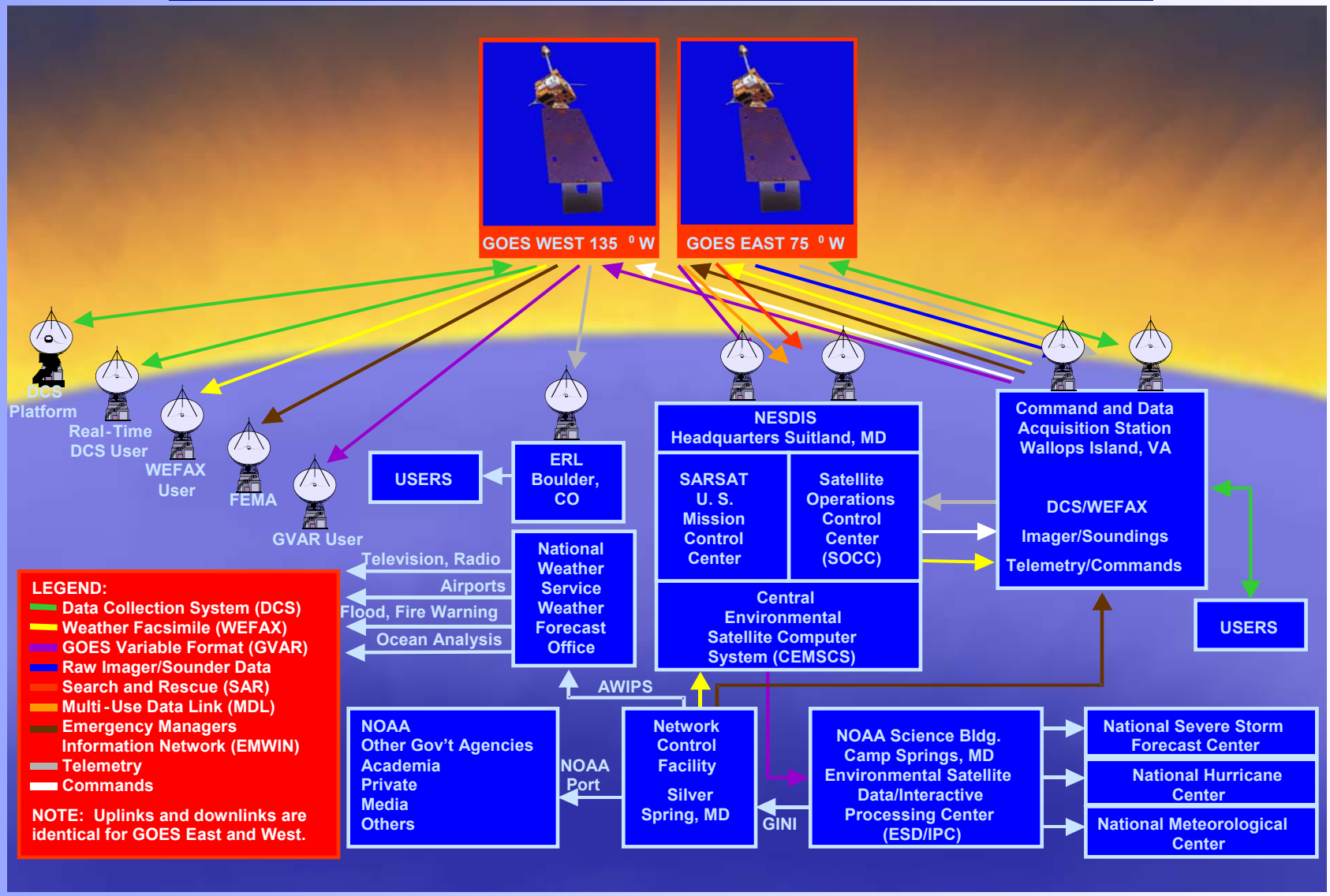


- To meet requirements, GOES continuously maintains operational satellites at two locations (75º West and 135º West)
  - On-orbit spare ready in case of failure
- GOES-I Series (8-12) currently operational
- GOES-N Series (13-15) under contract
- GOES-R Series is the follow-on continuity program to GOES-N Series

GOES R End-to-End Approach

- Implement process to identify and validate user requirements
- GOES-R End-to-End System includes Space and Launch Segment; Command, Control and Communications (C^3) Segment; Product Generation and Distribution Segment; Archive and Access Segment; and User Interface Segment.
- Cost Target consistent with acquired GOES I-P cost per satellite year
- Define System Level Architecture
  - Government notional baseline architecture (not final selection) used to establish cost, schedule, performance baseline, identify associated risk, and assess future system trades
  - Industry effort in FY04/05 to assess alternative architectures

GOES End-to-End System



GOES-R
NOAA Program Office

Steve Kirkner……GOES-R Program Manager

Sarah Jenkins……..…….. Secretary

Andrew Carson ……. HES Acquisition
Gus Comeyne……. Spacecraft Acquisition
Dan Flannagan…….. ABI Acquisition
Ben Diedrich…….. SEISS Acquisition
Eric Chipman……. SIS Acquisition
Les Shipley……. Ground Acquisition
Gus Ryberg……. Ground Acquisition
John Linn……. Ground Acquisition

Maggie Eckard……. Budget Specialist
Lisa Hurt…….. Budget Specialist

Jim Gurka……. Requirements
Don Gray ……. Requirements

Roger Heymann…….. Communications/ Frequency Request

Jay Moore……. Contract Officer

Elizabeth Carson…….. Acquisition Program Manager
David Zehr……. System Engineer (Integration)
Dan May……. System Engineer (Integration)
John Powell…… Document Manager

Michael Madden……. System Engineer

Ken Shere……. Ground Systems

Adrian Rad…… Risk Manager

Monica Coakley…….. Mission Requirements

Statement of Need

- Replacement Satellite required by end of 2012 to maintain GOES Continuity
- User Requirements  Improved Sensors
  - Better temporal, spatial and spectral resolution
  - Climate, coastal, and estuary measurements
  - Traditional meteorological requirements
- Requires Follow-on System
  - 10 year acquisition cycle
  - 2012 Launch Date
  - 2013 Operational Availability
  - Develop integrated end-to-end ground and satellite systems

Statement of Need
Supports NOAA Strategic Goals

- Ecosystem
  - Determine environmental impacts of chaotic processes
    - Ocean Color
    - Ocean Optical Properties
    - Ocean Turbidity
    - Ocean Currents
- Weather and Water
  - Real time weather data to accurately track and analyze severe weather events and reduce loss of life and property
    - Temperature Profiles
    - Lightening Detection
    - Cloud Measurement
    - Wind Currents
    - Space Weather
- Climate
  - Provide quantitative environmental data for use in weather and climate prediction and analysis
    - Ozone Layers
    - CO2 Concentration
    - Vegetation Index
- Commerce
  - Uninterrupted hemispheric observations and products for safe and efficient transportation and commerce systems
    - Volcanic Ash
    - Solar Radiation
    - Ice

GOES Customers
(Source of Requirements)

- **National Weather Service**
  - Weather Forecast Offices
  - National Center for Environmental Predictions (NCEP)
    - TPC (Tropical Prediction Centers)
    - Aviation Weather Center
    - Space Environmental Center
    - Storm Prediction Center
    - Hydro Meteorological Prediction Center
    - Climate Prediction Center
    - Ocean Prediction Center
    - Environmental Modeling Centers
  - National Operational Hydrologic Center
  - River Forecast Centers
- **NESDIS**
  - Synoptic Analysis Branch
- **National Center for Atmospheric Research**
- **National Marine Fisheries Service (NMFS)**
  - Alaskan Regional Office (AKR)
  - Alaskan Fisheries Science Center (AKC)
  - National Marine Mammal Laboratory (NMML)
  - Southeast Region Office (SER)
  - Southeast Fisheries Science Center (SEC)
  - Northeast Fisheries Science Center (NEC)
  - Northwest Fisheries Science Center (NWC)
  - Southwest Fisheries Science Center (SWC)
  - Office of Protected Resources (F/PR)
  - Office of Sustainable Fisheries (F/SF)
- **National Climatic Data Center**
- **Department of Defense**
  - US Army
  - US Air Force
  - US Navy

GOES Other Users

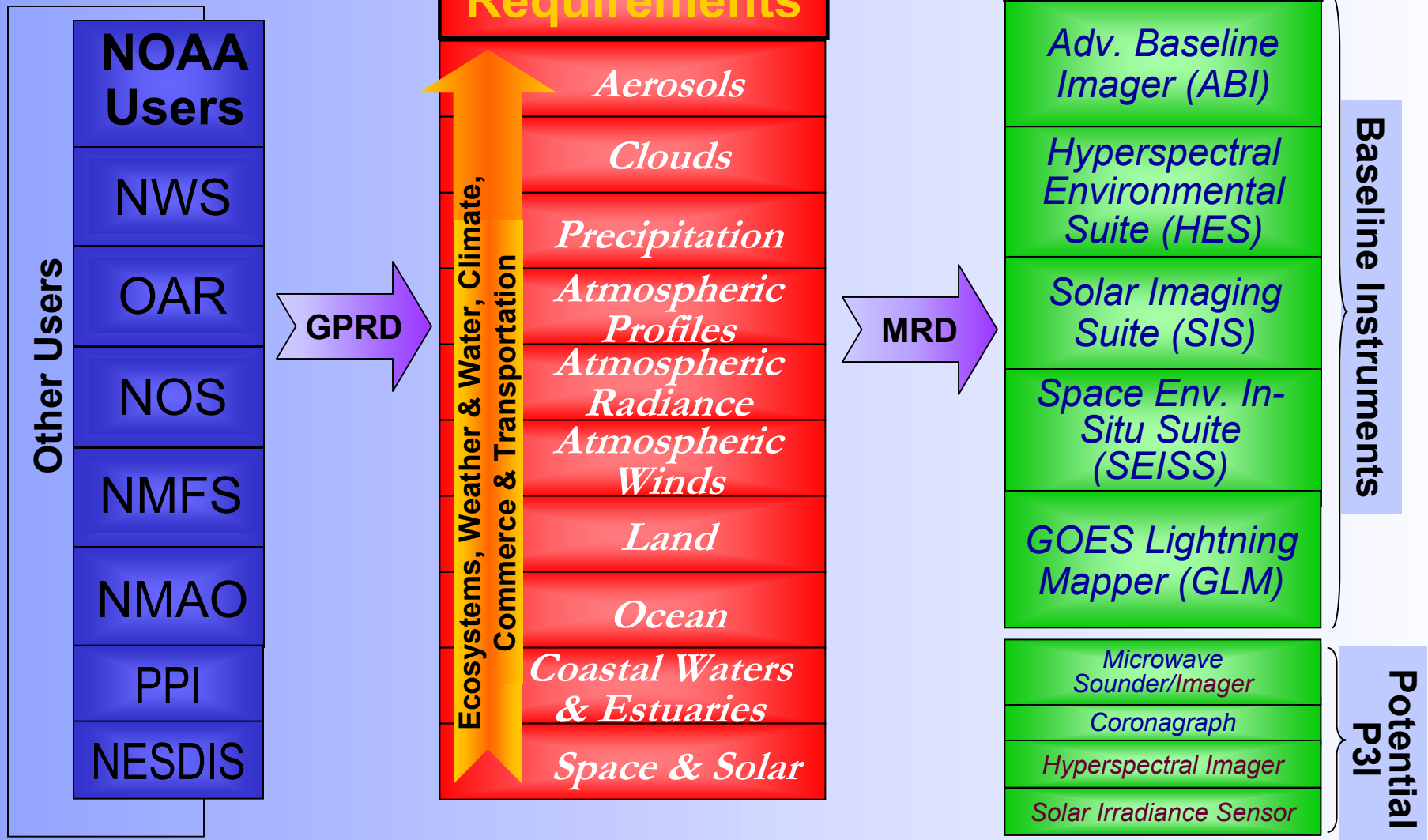
- Department of Interior (DOI)
- Department of Commerce (DOC)
- Department of Agriculture (DOA)
- Department of Energy (DOE)
- U S Department of Education
- Centers for Disease Control and Prevention
- Environmental Protection Agency (EPA)
- Bureau of Reclamation
- Soil Conservation
- Bureau of Land Management
- United States Forest Service
- State Division of Water Resources
- Flood Control Districts
- NASA
- Forensic Services (Law)
- Federal Emergency Management Agency
- Department of Transportation

- Private Meteorological Companies
  The Weather Channel, Accu-weather, WSI
- Media
  The Weather Channel, Associated Press, Radio and Television News Directors Association, Professional Meteorologists and Hydrologists
- Universities
  Colorado State University, University of Wisconsin, Brazilian Instito Nacional de Pesquisas Espaciais, University of Reading England
- International
  World Meteorological Organization Geneva (Switzerland), Regional Meteorological Training Centers (Barbados and Costa Rica), International Civil Aviation Organization Environmental (Canada), Search & Rescue-(USA, France, Russia, Norway, and Canada), UKMET (United Kingdom Meteorological Office), World Weather Watch Regional Basic Synoptic Network, European Organisation for the Exploration of Meteorological Satellite (EUMETSAT), European Center for Medium-range Weather Forecasting (ECMWF)
- Smithsonian Institute
  International Climate Change Research and Modeling
- Local Fire, Police, Safety Departments
- Industry
  Construction, Insurance, Energy Companies, Trucking and Transportation Companies, Agriculture

GOES-R User Requirements

- Extensive User Involvement
  - GOES User Conferences – 2001 and 2002
  - Data User Conference - 2003
- Draft Statement of Need – Draft Oct 03
- GOES-R Program Requirements Document (GPRD) – Feb 02
  - Consolidated initial set of requirements to direct trade and cost studies
  - NOAA's initial Mission Requirements Document (MRD) signed and delivered to NASA on Dec 6, 2002. Update produced July 11, 2003.
- Jun 03 Draft GPRD – final DUS signature planned for 2QFY04
  - Includes all NOAA/DOD requirements
  - Begins to identify other Federal Agencies user requirements
  - More complete end-to-end requirements
  - Refines Feb 02 Draft GPRD based on trade results & user input
  - Used to govern further definition & design efforts
  - Used for system requirements validation per NOAA Requirements Process
- GPRD will evolve as program matures
- **Third GOES User's Conference, *May 2004, Boulder, Colorado***

GOES-R Requirements Mapping



GOES N Products by Instrument

41 Products

29 Operational, 12+ Experimental

Clouds
Channel brightness temperature
Cloud drift winds from 3.9 um band
Cloud top pressure*
Effective cloud amount
Geopotential Height*
High Density Winds---Low Level*
High Density Winds---Mid Level*
High Density Winds---Upper Level
Hydro-estimator
Interactive Flash Flood Analyzer (?)
Layer precipitable water
Lifted index
Low Level High Density Satellite Winds
Low level winds (picture triplet)*
Multichannel precipitation
Precipitation Index Histograms
Real time remapped imagery
Site Specific clouds
Snow and Ice chart
Surface Skin Temperature*
Thermal Wind Profiles (gradient winds)
Total Precipitable Water*
Tropical Cyclone
Verticle Temperature and Moisture Profiles*
Volcanic Ash Product*
Water Vapor Winds
Wildfire Automated Bimass Burning Algorithms (WF_ABBA)
Aircraft icing (Exper.)*
Clear Sky Brightness Temperature (Exper.)
Fog (Exper.)*
Fog Depth (Exper.)
Hot Spot and Smole analysis from Hazard Mapping System (Exp)
Imager and Sounder calibration
Merged Automatic Cloud and Aerosl Detection (MACADA)
Ozone estimate (Exper.)
Radiances (Exper., 3 layers)
Reflectivity (Exper.)
Sea Surface Temperature (Exper.)*
WINDEX (Exper.)
RAMSIS movies

Green = Imager (ABI)

Orange = Sounder (HES)

*Asterisk indicates no name change

GOES-R Observational Requirements

Preliminary Instrument Allocation

~152 Total Products by Data Type/Coverage Area

Absorbed Shortwave Radiation
Aerosol Detection
Aerosol Particle Size
Aircraft Icing Threat
Atmospheric Vertical Moisture Profile
Atmospheric Vertical Temperature Profile
Capping Inversion Information
Clear Sky Masks
Cloud & Moisture Imagery
Cloud Base Height
Cloud Ice Water Path
Cloud Layers / Heights and Thickness
Cloud Liquid Water
Cloud Optical Depth
Cloud Particle Size Distribution
Cloud Phase
Cloud Top Height
Cloud Top Pressure
Cloud Top Temperature
Cloud Type
CO Concentration
CO_2 Concentration
Convection Initiation
Derived Motion Winds
Derived Stability Indices
Downward Longwave Radiation

Downward Solar Insolation
Dust/Aerosol
Energetic Heavy Ions
Enhanced "V"/Overshooting Top Detection
Fire / Hot Spot Imagery
Flood/Standing Water
Geomagnetic Field
Hurricane Intensity
Ice Cover/ Landlocked
Land Surface (Skin) Temperature
Lightning Detection
Low Cloud and Fog
Mag Electrons & Protons: Low Energy
Mag Electrons & Protons: Med & High Energy
Microburst Winds
Moisture Flux
Ocean Currents
Ocean Color
Ocean Optical Properties
Ocean Turbidity
Ozone Layers
Ozone Total
Pressure Profile
Probability of Rainfall
Radiances

Rainfall Potential
Reflected Solar Insolation
Sea & Lake Ice/ Displacement and Direction
Sea & Lake Ice/Age
Sea & Lake Ice/Concentration
Sea & Lake Ice/Extent and Characterization
Sea & Lake Ice/Surface Temp
Sea Surface Temps
Snow Cover
Snow Depth
SO_2 Concentration
Solar and Galactic Protons
Solar Flux: EUV
Solar Flux: X-Ray
Solar Imagery
Surface Albedo
Surface Emissivity
Suspended Matter
Total Precipitable Water
Total Water Content
Turbulence
Upward Longwave Radiation
Vegetation Fraction
Vegetation Index
Visibility
Volcanic Ash

ABI – Advanced Baseline Imager

HES – Hyperspectral Environmental Suite

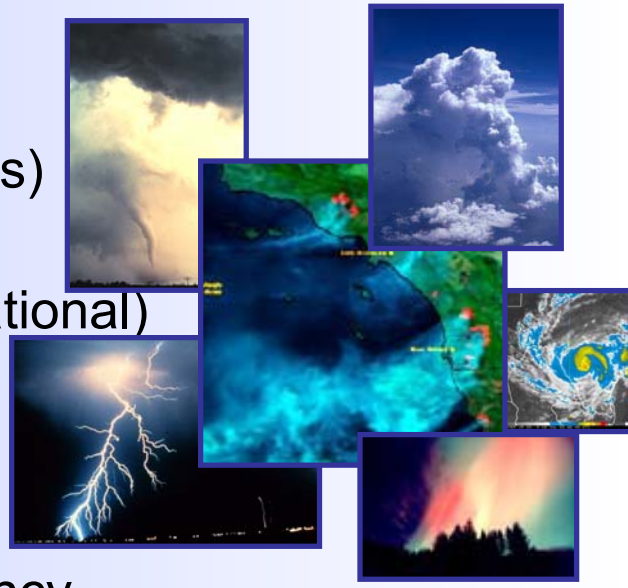
SEISS – Space Env. In-Situ Suite

SIS – Solar Instrument Suite

GLM – GOES Lightning Mapper

GOES Product Improvements

- Severe storm and flood warnings
- Tropical cyclone (hurricane reconnaissance and warnings)
- Hydrologic forecasts and water resources management
- Short-term and mesoscale forecast
- Ocean surface and internal structures forecasts
- Medium range forecast outlook (out to fifteen days)
- Solar and space environmental forecasts
- Aviation forecasts (domestic, military, and international)
- Ice conditions forecasts
- Seasonal and inter-annual climate forecasts
- Decadal-scale monitoring of climate variability
- Environmental air quality monitoring and emergency response
- Fire and volcanic eruption detection and analysis
- Long-term global environmental change assessment



Benefit Areas Identified

- Aviation
  - Improve plane deicing efficiency
  - Improve volcanic ash avoidance
  - Reduce airborne lightning
  - Reduce delay times
  - Avoid radiation storm damage from galactic events
- Insurance/Emergency Services
  - Improve preposition prior to disasters
  - Reduce recall and delay times
- Agriculture
  - Increase crop production
  - Reduce water waste
  - Reduce water reallocations
- Maritime Boating
  - Improve hurricane lead time
  - Improve thunderstorm warning
  - Reduce boat damage
  - Improve severe lightning warnings
  - Better understanding of weather conditions
- Transportation
  - Improve severe weather lead-time
  - Reduce delay times
  - Allow in vehicle monitoring with GPS guidance
- Utilities (Electric, Nat Gas)
  - Improve temperature accuracy
  - Improve load forecasting
  - Reduce power outages
  - Reduce major blackouts and pipeline damage resulting from galactic storms

System Improvements

GOES N Instruments	GOES R Notional Baseline
Imager 5 Channels	Advanced Baseline Imager (ABI) 16 Channels
Multispectral Sounder 18 Channel	Hyperspectral Environmental Suite (HES) 1500 Channel Sounder 14 Channel Imager
Solar X Ray Imager Space Environmental Monitor	Solar Imaging Suite (SIS) Space Environmental In Situ Suite (SEISS)
N/A	GOES Lightning Mapper (GLM)

GOES R Imager Improvements

Parameter	GOES I - N Imager	GOES R ABI
Spatial Resolution	Visible ~1.0 km IR ~4.0 km	1 Visible 0.5 km 3 Vis/IR 1.0 km **0.47, 0.68 & 1.61μm** 12 IR 2.0 km **1.38 μm & >2.0 μm**
Coverage Area	Full Disk	Full Disk
Coverage Rate	Full Disk: 30 min CONUS: 15 min	<u>Scan Mode 3</u> Full Disk: 15 min CONUS: 5 min Mesoscale: 30 sec <u>Scan Mode 4</u> Full Disk: 5 min CONUS: 5 min (in FD)
Spectral Bands	5 bands	16 bands
Low Light Capability	No	Yes

GOES Sounder Improvements

Parameter	GOES I and N Sounder	GOES R HES
Spatial Resolution	Visible ~1.0 km IR 10.0 km	Visible: 1.0 km SW/M: 4.0 km 62 ° LZA: 10.0 km Coastal Waters: 0.3 km
Coverage Area	CONUS	62° Local Zenith Angle (LZA)
Coverage Rate	CONUS: 60 min	62 ° LZA: 60 min SW/M: 5 min **(1000 km x 1000 km)** Coastal Waters: 3 hour **(1000 km x 400 km)**
Spectral Bands	19 Sounding bands	~1500 Sounding bands 14 Imaging bands
RMS Temperature Error	~2° K	~1° K
RMS Humidity Error	~20%	~10%
Low Light Capability	No	Yes

SIS/SEISS Improvements

- Space weather on GOES R will be measured with
  - Solar Imaging Suite (SIS)
  - Space Environmental In Situ Suite (SEISS)

- Suite will be capable of performing the following tasks
  - Near Real time measurements
  - Operate and transmit during eclipses
  - Each instrument will operate independently

- Extreme UV measurements – 5 channels to 7 or 8 channels

GOES Lightning Mapper

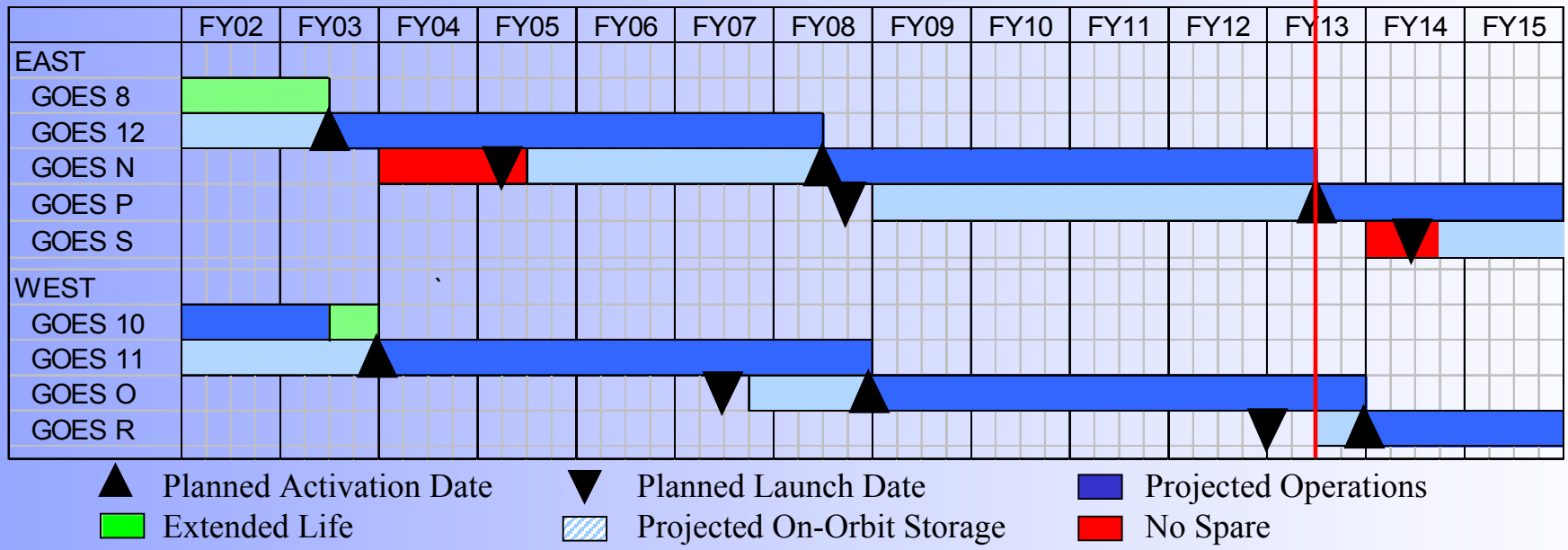
- New NOAA instrument
- Hemispheric or CONUS Coverage
- Detects total strikes including intra-cloud, cloud to cloud, and cloud to ground lightning
  - Land Based Ground Systems only detect Cloud to Ground
  - Cloud to Ground only accounts for 15% total lightning
- 10 km resolution (1 km goal)
- 1 km mapping accuracy (100 m goal)
- Continuous detection
- Increased coverage over lands and oceans
  - Currently No Ocean Coverage, and
  - Limited Land Coverage in Dead Zones

Ground Improvements

Parameter	GOES I and N	GOES R
Rebroadcast Data Rate	2.11 Mbps (GVAR)	5 - 24 Mbps (under review)
Total Downlink	2.1 Mbps	132 Mbps
Daily Output	181 Gb	16000 Gb
Total Products	41	160
Class Data Storage	N/A	Daily: .5TB 7 year life: 1100TB
Raw Data Storage	0 days	30 days

GOES-R Need Date

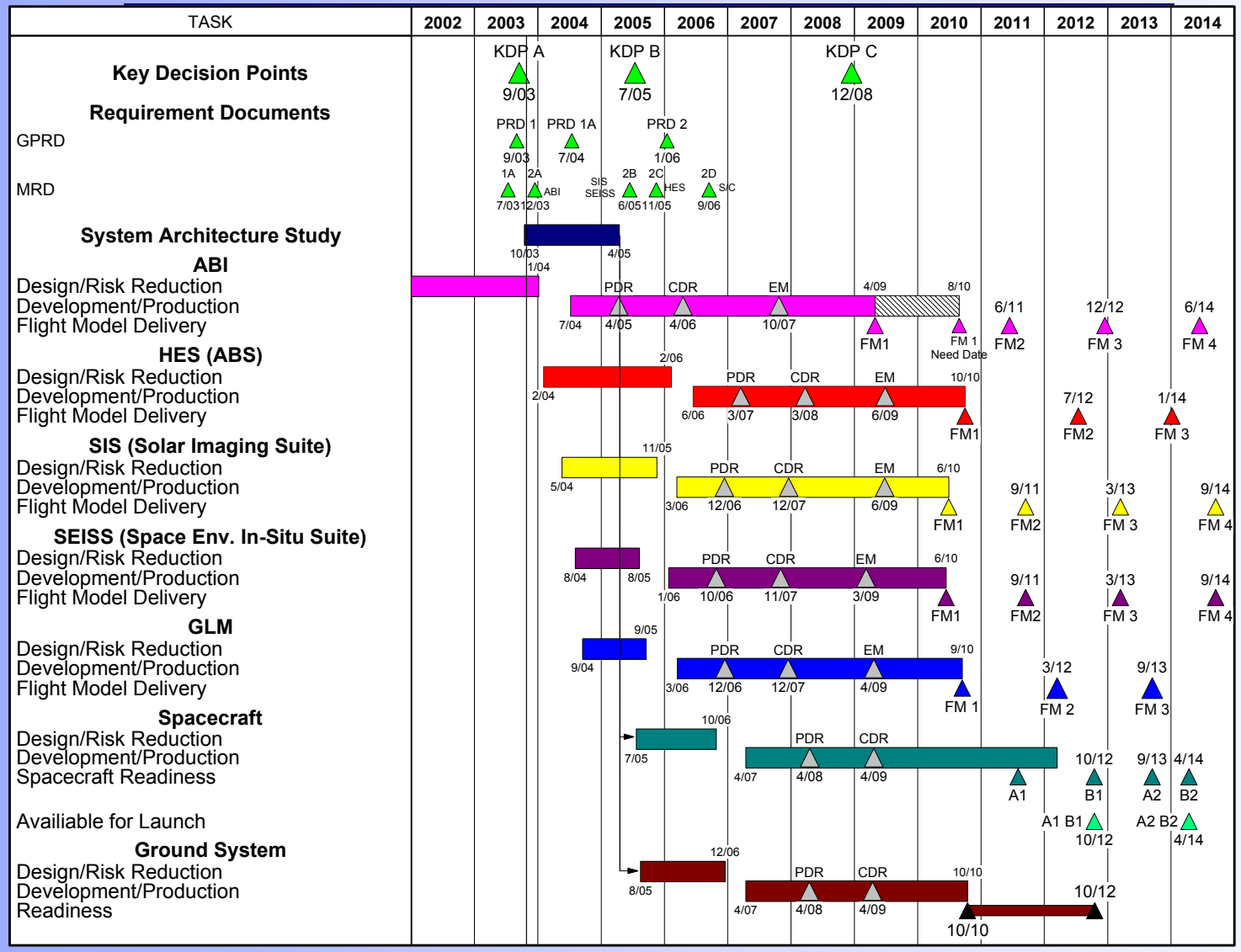
GOES R must be operationally available (launched and checked out) by this date to provide coverage in the event of an unexpected loss of O or P



- Launch dates driven by need for 2 operational and at least 1 on-orbit spare at all times
- GOES-R must be launched by Oct 2012, in order to be sufficiently checked out and available as on-orbit spare when P is turned on (planned for Apr 2013)
- 12, N, P projected operations determine when R must be launched as spare – next scheduled update is 2008 (planned N turn on)
- 10, 11, O projected operations affect system availability percentage, but not R need date

GOES-R Schedule

(August 1, 2003)

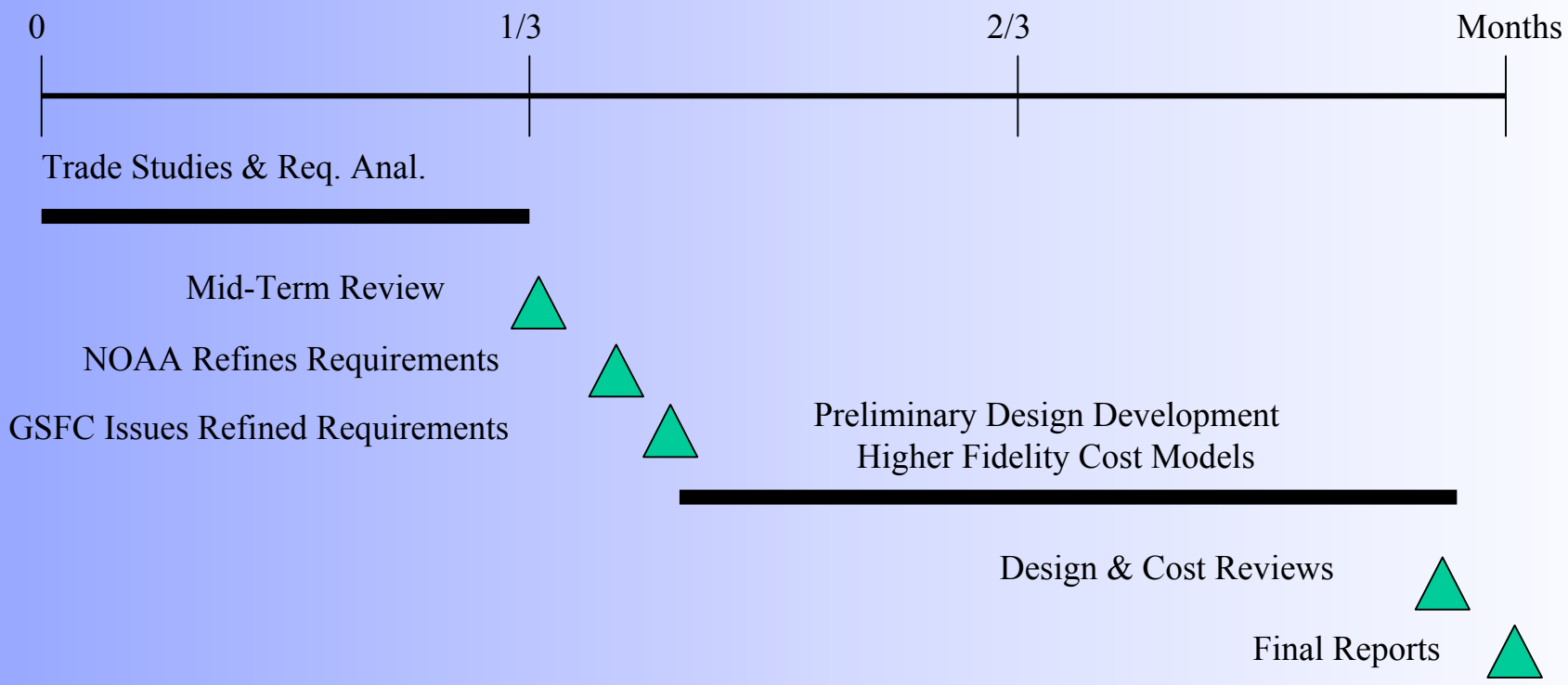


A SAT = ABI + SIS + GLM + Services
B SAT = HES + SEISS + Services

Program Assumptions for Acquisitions

- Major Instruments GFE to Spacecraft 18-24 months prior to first launch
- Launch vehicle is GFE
- Ground System to Space System Interface Control Document developed by NOAA/NASA
- Approximate 4-6 month gap between Design/Risk Reduction and Production/Operations Phases
- 60 month duration on implementation phase for each major instrument and spacecraft

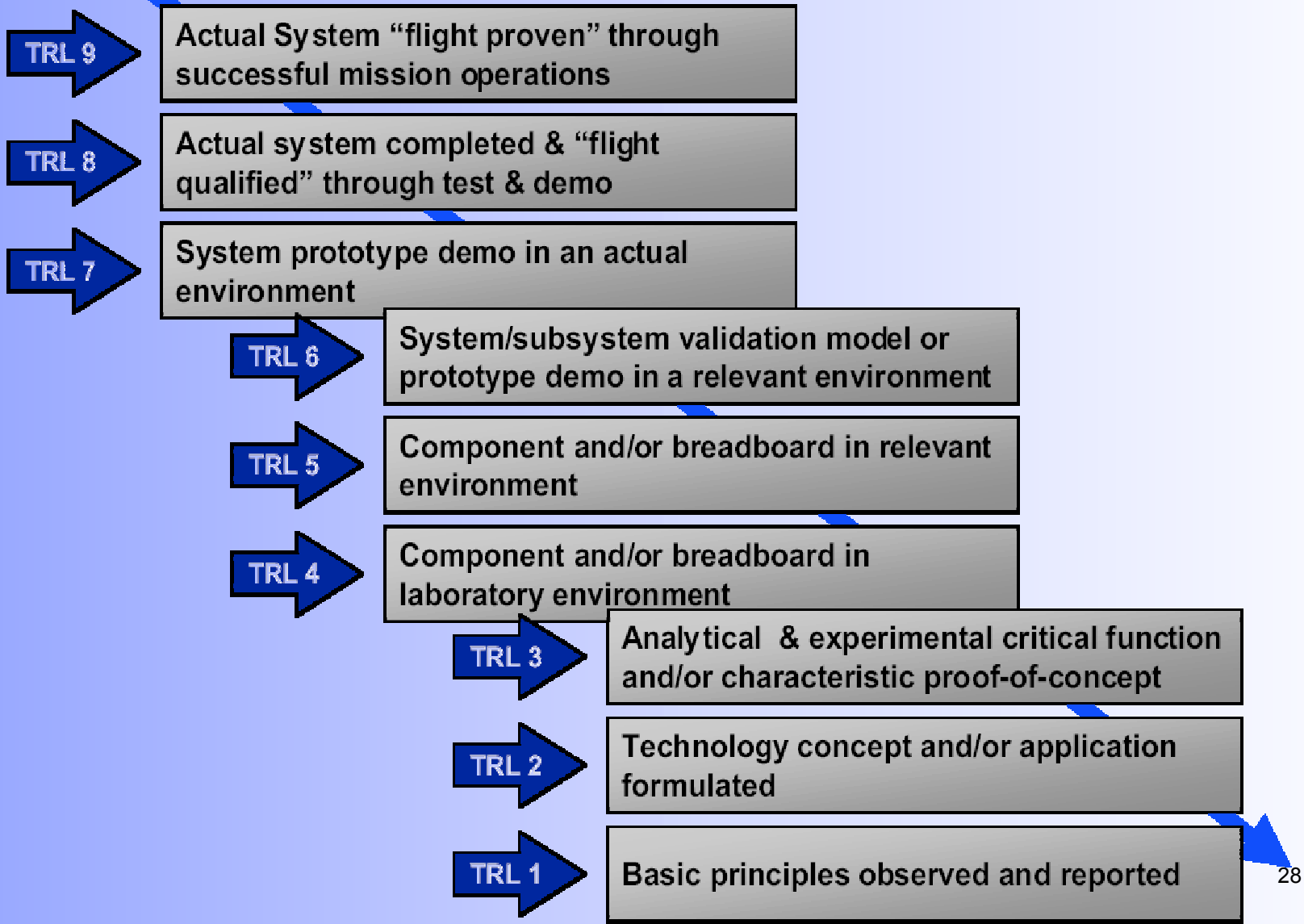
Typical Design/Risk Reduction Schedule (12 to 24 Months)



Technology Infusion

- Design/Risk Reduction Phase
  - Leverage contractors knowledge and experience
  - Determine technology availability versus requirements
  - Demonstrate a technology readiness level of TRL-6 by Preliminary Design Review (PDR)
    - Design/Risk Reduction Contractors provide Risk Mitigation Plan
- Leverage Government and FFRDC Technical Knowledge and Technology Availability
  - Participate in the development of technology roadmaps
  - Provide point designs for the instruments and segments
- Funding GSFC technologies *i.e.* encoders and detectors
- Attaching Catalog of Known Technologies to RFP's *e.g.* GIFTS

Technology Readiness Level



End to End System Architecture

- System Architecture Definition
  - Explore GOES-R end-to-end architectural options - existing notional baseline or establish new one
  - Define links and applicability to NOSA/National/International architectures

- System Architecture Objectives
  - Requesting Alternative Design Approaches from Industry.
  - Permitting Varying Technical/Scientific Approaches to be Applied.
  - Allowing Industry To Apply Its State-of-the-Art Advancement.
  - More Flexibility in Contractor, and Government Solutions

Architecture Study Goals

- Will Accomplish
  - Initiation of End-to-End Integration Studies
  - Identification of Risk Factors Prior to Formulation Contract
  - Start of Accommodation Studies
  - Development of Life Cycle Cost Estimate
  - Study of Cost Containment Strategies for Operation and Maintenance
  - Assessment of Distributed, Consolidated, and Other Space Segment Architecture
  - Analysis of Rebroadcast Options and Alternatives
  - Establishment of System Integrator Functions
  - Identification of Global Observation Possibilities
  - Study of Alternatives for Handling Auxiliary Service

Baselined Instrument Schedules FY04 Activities

- ABI
  - Development/Production
    - Jan 04 Final RFP Release
    - Feb 04 Proposals Received
    - Jul 04 Contract Award
- HES
  - Design/Risk Reduction
    - Nov 03 Final RFP Release
    - Mar 04 Contract Award (No BAFO)
- SIS
  - Design/Risk Reduction
    - Dec 03 Draft RFP Release
    - Dec 03 Acquisition Strategy Meeting
    - Jan 04 Final RFP Release
    - Feb 04 Proposals Received
    - May 04 Contract Award
- SEISS
  - Design/Risk Reduction
    - Dec 03 ASM
    - Jan 04 Draft RFP Release
    - Mar 04 Final RFP Received
    - May 04 Proposals Received
    - Aug 04 Contract Award

Summary

- GOES-R is an End-to-End System
  - System Architecture and Integration
  - Instruments
  - Spacecraft/Launch Services
  - Command, Control, Communications
  - Product Generation and Distribution
  - Access and Archive
  - User Interface
- GOES-R will provide 160 products that meet the User Requirements
  - Factor of 4 over current products (40)
  - Factor of 60-80 increased data rates
- GOES-R Launch Date is Oct 2012
  - Major Acquisition require 10 years
- GOES-R is an action-packed acquisition program to monitor sun, space, atmosphere, land, and ocean real time conditions; thus, allowing NOAA/NWS and users to achieve quicker, more efficient environmental forecast that ultimately protect the American Public.

GOES CORE VALUES

*inte**G**rity*
*inn**O**vation*
*exec**E**llence*
*re**S**pect*

***T**rust*
***E**nhancing*
***A**tmospheric*
***M**onitoring*

Mission Statement

To work as an effective, integrated Government & Industry team to ensure the economical, timely, and successful delivery of a highly technical Geosynchronous Space and Earth Environment Observing Satellite System used to predict the weather and climate change; to protect life, property, and the nation's vital interests; and to enhance the global quality of life.

February 1998